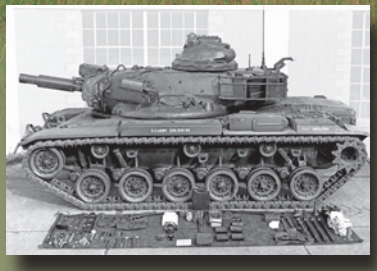
TANKS AT THE IRON CURTAIN 1960–75



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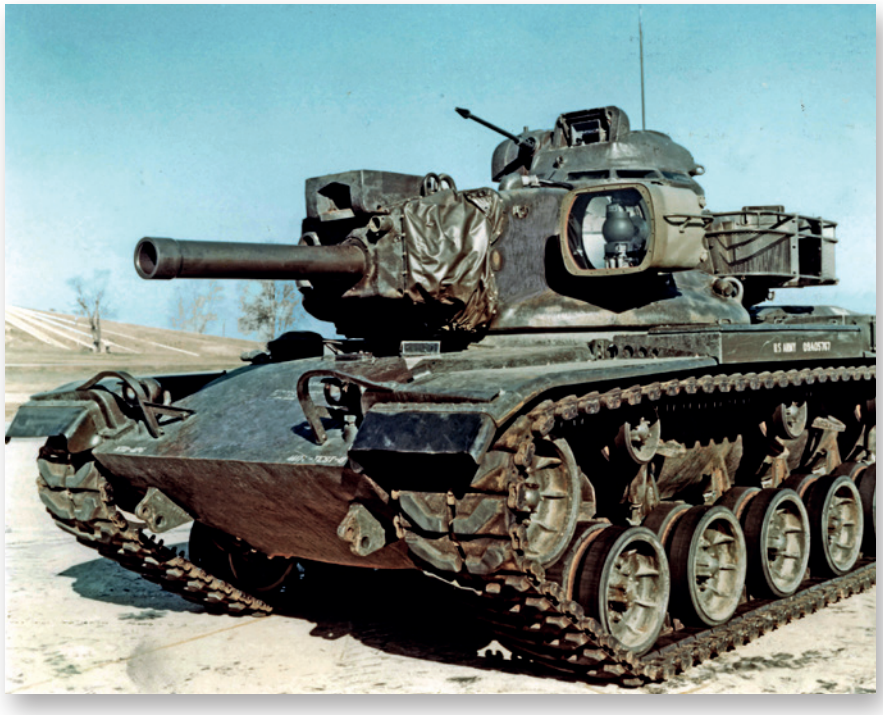
NEW VANGUARD 308

TANKS AT THE IRON CURTAIN 1960–75



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TANKS AT THE IRON CURTAIN 1960–75

INTRODUCTION

This book is the second of three to survey the tanks facing each other along the Iron Curtain from the end of World War II to the end of the Cold War. The first volume dealt with the tanks that remained in service from World War II, as well as the first generation of post-war tank designs. This volume covers the next generation of tanks in 1960–75. The third volume covers the 1975–90 generations. Due to the large number of armies belonging to NATO and the Warsaw Pact, the focus is on the more consequential armies including the main protagonists and the forward deployed allies. In the case of the Warsaw Pact, greater attention is paid to the "Northern Tier" of East Germany, Poland, and Czechoslovakia, and less to the "Southern Tier" of Hungary, Romania, and Bulgaria. Likewise, coverage is greater for the major NATO armies such as the US Army, British Army, and Bundeswehr, and less on the smaller armies that did not manufacture their own tanks.

A few themes dominated tank development in the period of 1960 to 1975. As guided antitank missiles became more effective and more widely deployed, politicians began to ask whether the days of the tank as the dominant land weapon were now past. "The tank is dead," was a refrain heard in Washington DC, London, and Moscow. At the same time, visionary vehicle designers envisioned a revolutionary new tank, protected against the ravages of nuclear and chemical warfare, and armed with its own guided weapons. Such a weapon might dominate a future battlefield. Time after time, such advanced designs proved to be too costly and too complicated. Instead, more conventional designs predominated through this period. Although there was never a direct conflict between NATO and the Warsaw Pact, a surrogate conflict in the Middle East in 1973 provided a glimpse of what a battle in central Europe might resemble. The lessons of

Cold War armies had been attempting to adapt to the nuclear battlefield since the late 1950s. When introduced in 1963, the T-55A took the next step in this direction, adding anti-radiation liner to the insides of the crew compartment. Due to the limited volume of the interior, this required the addition of enlarged combings around the two roof hatches, the distinctive identification feature of this variant.

Volgograd's Obiekt 934 was one of two light tanks armed with the 100mm 2A48 gun that was intended to replace the PT-76 amphibious tank. Next to Obiekt 934 is its competitor, the Kurgan Obiekt 685. In the event, the Soviet Army abstained from acquiring a new light tank.

the 1973 war would reverberate through the next generation of tanks that are the subject of the third book of this series.

THE TANKS, DOCTRINE, AND ORGANIZATION

Soviet Union

In 1960, the Soviet Union was producing a comprehensive array of tanks that would form the basis of the Soviet Army's tank force through the decade. In the light tank category, the production of the PT-76B ended in 1967. Development of the improved PT-76M with a redesigned hull was completed, but did not enter production. In 1960, the Stalingrad Tractor Plant (STZ) began work on the Obiekt 906, a substantially redesigned version armed with an 85mm D58-T gun. This was intended both to replace the PT-76 in tank units, as well as the ASU-85 assault gun in the airborne force. It was not accepted for production. The issue was re-examined in the early 1970s with competitive designs from the Kurgan plant (Obiekt 685) and the Stalingrad plant (Obiekt 934), both armed with the 100mm 2A48 gun. These failed to win support, in large measure because the army had grown accustomed to using wheeled reconnaissance vehicles in reconnaissance roles. As a result, the PT-76 lingered on in the reconnaissance role through the 1970s.

The backbone of the Soviet tank force was the T-55 tank that entered production in 1958. It was an evolutionary upgrade of the T-54A tank, incorporating a more comprehensive PAZ (*Protivoatomnaya zashchita*: counter-radiation protection). In terms of armor, firepower, and mobility, it was very similar to the T-54A.

Although the PAZ protective suite on the T-55 shielded the crew from radioactive fall-out, it did little to protect them against the radiation from a nuclear blast. A type of lead-impregnated plastic was developed along with an improved air filtration system to better protect against fall-out and chemical weapons than the T-55's overpressure system alone. These modifications were incorporated into the improved T-55A tank and production began in August 1963.

The D10-T 100mm gun used on the T-55 was a 1944 adaption of an existing naval gun and not optimized for the antitank role. In the late 1950s, the new D54-T 100mm gun had been developed that offered significantly better anti-armor performance. The two main medium tank design bureaus in Kharkov and Nizhni-Tagil offered both an evolutionary and revolutionary approach to adopting the new gun. Aleksandr Morozov's tank design bureau at Kharkov's Malyshev tank plant offered a revolutionary solution, the radical new Obeikt 430 tank. It was a completely new design incorporating an innovative opposed-piston diesel engine, a lightweight suspension, composite armor in the hull, and the D54-TS 100mm gun. Politics and changing threat perceptions intervened before it entered production.

In 1958, premier Nikita Khrushchev had been shown the new T-12 100mm Rapira smooth-bore antitank gun. He insisted that the Soviet Army receive at least 200 tanks armed with this weapon by 1959. Leonid Kartsev's design bureau at the *Uralvagon Zavod* (UVZ: Ural Rail-Car Factory) in Nizhni-Tagil was assigned this task. The T-12 ammunition was not well suited to tank use due to the length of its propellant casing. Instead, the new U5-T Molot (hammer) gun was developed that used the advanced projectile of the Rapira, but which had an increased 115mm bore to provide the ammunition with shorter dimensions better suited to Soviet tank turrets. Uralvagon developed two derivatives of the T-55 to fit the new generation of guns, the Obiekt 165 armed with the D54-TS as preferred by Moscow's tank bureaucracy, and the Obiekt 166 Yubileniy (Jubilee) armed with "Khrushchev's bastard," the 115mm U5-T gun.

In December 1960, the new American M60 tank was issued to US troops in Europe for the first time. The initial Soviet evaluation of the design was issued to senior army officers in January 1961. It judged that the M60 had better glacis armor than the previous M48 and that its new 105mm gun was superior to the 100mm gun on the T-54/-55. Furthermore, the new D54-T gun was inadequate to frontally penetrate the new NATO tanks. The commander of the Soviet Ground Forces, Marshal V.I. Chuikov, was infuriated to learn that NATO was receiving a 105mm tank gun. Chuikov, the victor of Stalingrad, was a coarse and profane soldier of the old school,

The T-62 tank was an evolution of the T-55, using essentially the same powertrain and suspension, but with an elongated hull. The new U5-TS 115mm gun required a new turret design of a more hemispherical shape than the T-55's distinctive egg shape.

The T-62 underwent continual upgrades during its production run. Starting in 1971, the turret was modified with the addition of a mounting for the 12.7mm DShKM heavy machine gun to deal with the attack-helicopter threat.

with no subtle understanding of tank technology. When informed that the next generation Obiekt 430 tank would still be armed with a 100mm gun even though NATO now had a 105mm gun, he made it abundantly clear that he wanted the next Soviet tank to have a bigger gun than NATO. Chuikov didn't want to hear any technical arguments about the advantages of the D54-T 100mm gun. Since Khrushchev had already decided that heavy tank production cease in favor of missile tanks, this meant that a larger gun would have to be mounted on the medium tanks.

Chuikov called the head of the GBTU Main Armor Directorate, Marshal Pavel P. Poluboyarov, into his office in Moscow for a severe dressing down. Poluboyarov admitted that Uralvagon had developed a tank with a 115mm gun, but that there had been problems with the stabilizer. Chuikov screamed at Poluboyarov, "Why are you jerking me around over this stabilizer? I don't care if it's mounted on a pig! Just come up with this gun!" Chuikov demanded that a more powerful gun be fielded immediately and he didn't care whether it was mounted on Kharkov's preferred Obiekt 430 modified for the 115mm gun or Nizhni-Tagil's Obiekt 166. Since the Obiekt 166 had already been designed around the 115mm gun, it was ready for production. On the other hand, it would take time to adapt the Obiekt 430 to the 115mm gun, called the Obiekt 432. This was largely due to the need to develop split-case 115mm ammunition suitable for Obiekt 432's autoloader. The impatient Chuikov made it very clear he wanted a more powerful tank immediately.

To placate the tank bureaucracy as well as Chuikov, in July 1961 the head of the defense industry recommended adopting both the Obiekt 166 with the U5-TS Molot 115mm gun as well as the related Obiekt 165 with the rifled D54-T 100mm gun. Government approval took place on August 12, 1961, with the Obiekt 166 being designated as T-62. On January 8, 1962, Obiekt 165 was accepted for Soviet Army use as the T-62A. The T-62 gradually replaced the T-55 on the production lines at Kharkov and Nizhni-Tagil, though it remained in production at Omsk until 1978, mainly for the export market.

These decisions led to the production of four different ammunition types for the medium tanks – two different 100mm and two different 115mm types. Clearly, this had to be simplified. The D54-T 100mm rifled gun offered better

accuracy than the U5-TS Molot 115mm gun at longer ranges, but testing of production guns found performance problems when firing its APDS (armor-piercing, discarding-sabot) ammunition due to sabot interactions with the muzzle brake. The U5-TS Molot had its own accuracy problems due to its hasty origins since it was developed by simply boring out the 100mm rifled gun rather than starting from scratch; barrel stiffness was marginally inferior to the original 100mm gun. The U5-TS had some advantages over the D54-T in terms of cost since the 115mm APFSDS (armor-piercing, fin-stabilized, discarding-sabot) projectile used a steel penetrator which was much less costly than the 100mm APDS projectile with an expensive tungsten carbide core. By switching the 115mm penetrator from steel to tungsten carbide, its armor penetration could be substantially enhanced and give it performance better than the 100mm D54-T, as was in fact done later. As a result, Moscow ordered Uralvagon to cancel any production of the T-62A with the new 100mm gun beyond the first five assembled in late 1962.

The T-62 became the premier Soviet tank in the 1960s. Prestige tank divisions such as those in the GSFG (Group of Soviet Forces – Germany; GSVG *Gruppa sovetskikh voysk v Germanii*) received the T-62 starting in 1963. By 1971, about 60 percent of Soviet tanks in the GSFG were T-62 tanks, rising to 75 percent by 1972. In 1973, T-62 tanks also began to be deployed in the GSFG motor rifle divisions.

The rise of the missile tank

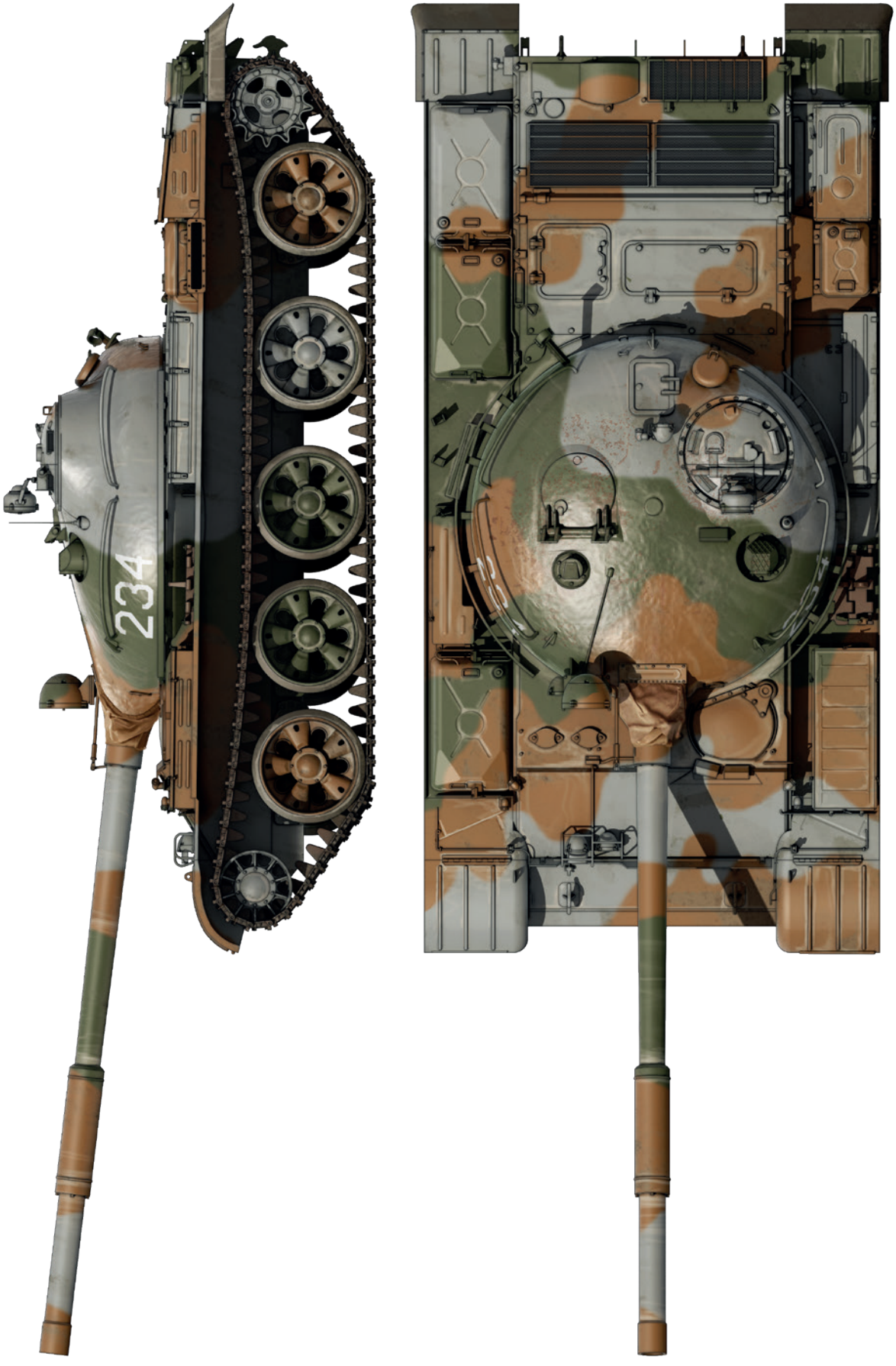
Soviet heavy tank development reached its pinnacle in the late 1950s with competing design bureaus in Leningrad and Chelyabinsk. The heavy tank design bureaus developed a pair of impressive new tanks towards the end of the 1950s. They were both armed with a stabilized 130mm M-65 gun and were fitted with thick frontal armor that was proof against 122mm projectiles. Chelyabinsk's Obiekt 770 heavy tank was the more conventional of the two, and comparable to contemporary NATO types such as the British Chieftain or American M60A1. A more unusual alternative was Leningrad's Obiekt 279. It used an unusual hull with four sets of tracks to provide far lower ground pressure. The design was the ultimate response to the nuclear battlefield since tests found that a tank with such a hull configuration was less apt to be overturned due to a nearby nuclear blast. In the event, Soviet heavy tank development was halted in 1960 due to the whim of premier Nikita Khrushchev.

Khrushchev viewed heavy tanks as dinosaurs that would be slain on the modern battlefield by the new generation of antitank missiles. As a result,

A

T-62, GROUP OF SOVIET FORCES – GERMANY

The Soviet Army engineer forces periodically updated its basic "Manual of Engineering Equipment and Methods for the Camouflage of Ground Forces". The manual suggested three different color combinations for verdant, winter, and desert conditions. This shows the verdant scheme as applied to a T-62 tank, consisting of patches of gray and brown over the usual camouflage green (*zashchitniiy zeleno*). The Soviet Army did not use these camouflage schemes on a regular basis, leaving most of its tanks in the uniform camouflage green color. Camouflage painting was sometimes undertaken during large wargames as part of the exercise, with the work usually being done by dedicated engineer teams with an associated truck-mobile POS (*Polevoy okrasochnoy stanitsa*: Field Painting Station). Tactical markings usually included a three-digit side number (*Bortovoy nomer*). The Soviet numbering practice was deliberately non-standard and varied from division to division. The two most common patterns were to use the numbers in the sequence Battalion+Company+Tank, or Company+tank number (two digits).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A number of impressive new tanks were in development in the late 1950s prior to Khrushchev's cancellation of heavy tank programs. This is the Chelyabinsk Obiekt 770, armed with an M-65 130mm gun. Weighing 55 tonnes, it was fitted with a 500hp diesel engine with a maximum speed of 39km/h.

the Soviet government ordered an end to the development of heavy tanks on July 19, 1960. Nevertheless, production of the T-10M heavy tank continued until 1965. The reason for the delay in ending heavy tank production was the advent of newer NATO tanks such as the M60A1 and Chieftain that posed a challenge for Soviet medium tanks due to their thicker armor. The 122mm guns on the T-10M made them the most powerful tanks in the Soviet arsenal in the mid-1960s. There was even a short-lived organizational switch to a heavy tank division in a few units, including the 13th Tank Division at Riesa and the 25th Tank Division in Vogelsang in East Germany in 1965. As newer tank types such as the T-62 appeared, the heavy tanks began to disappear. By 1969, the heavy tank divisions had one of their heavy tank regiments replaced with a medium tank regiment. A year later, the heavy tank divisions disappeared in Germany with the units reverting to standard tank divisions based on medium tanks. Heavy tank regiments were gradually retired into reserves or used for training purposes. In 1974, there were still about 220 T-10M tanks in the GSFG including two training regiments with the Berlin Brigade, a tank regiment with the 3rd Shock Army and a battalion in the 8th Guards Army. With the demise of heavy tanks, the Soviet Army began to drop the term "medium tank" (Sredniy tank) in favor of Standard Combat Tank (Osnovnoy boevoy tank). This was echoed in NATO with a shift to terms such as Universal tank, Main Battle Tank, and Standard-Panzer.

In place of heavy tanks, Khrushchev wanted to field a new generation of missile-armed tanks that would offer superior anti-armor penetration at longer ranges than conventionally armed tanks. As a result, all of the Soviet tank design bureaus began the development of missile tanks based on a July 4, 1959 government decree. Many of these designs were based on Kharkov's new Obiekt 430 chassis. Some used fixed casemates with elevating launchers for antitank guided missiles, while a few were turreted tanks firing large-caliber guided projectiles. The first of these was Nizhni-Tagil's Obiekt 150, a derivative of the T-55/T-62 family, armed with the new 3M7 Drakon missile.

Testing of the Obiekt 150 took place at the Kubinka proving ground in May–June 1963, and a production-ready vehicle was displayed to Khrushchev on September 14, 1964, shortly before his ouster. On witnessing the Obiekt 150 in action, Khrushchev exclaimed "The tank has no future against this weapon!" Although the Obiekt 150 worked well enough, Khrushchev was overthrown by a coup in October 1964 over strategic military issues related to the fumbled 1962 Cuban missile deployment, as well as his impulsive political style. His "hare-brained schemes" were a particular source of frustration in the army.

One of the most unusual heavy tanks in development in 1960 was the Obiekt 279, sometimes called the Kotin tank after the Soviet tank designer. It used four track assemblies to provide sufficient footprint to avoid being overturned by the detonation of a nearby nuclear blast.

The Obiekt 150 remained in limbo and other missile tanks lingered in development. The army was not fond of missile tanks for three main reasons. They tended to carry a very modest number of missiles due to their large volume; they were not well suited to infantry support with high-explosive projectiles; and finally, they were extremely expensive both due to the high cost of their missiles as well as the cost of their elaborate fire control systems. The Obiekt 150 was revived in the late 1960s due to concern over the inability of the T-62 to deal with the heavily armored British Chieftain. The Obiekt 150 was viewed as a stop-gap until the next-generation tanks with a new 125mm gun arrived. As a result, in 1968 it was put into low-rate production with 220 completed in 1968–70. It was classified as the IT-1 (IT: *istrebitel tankov* – tank destroyer).

The IT-1 was issued to battalions in the Byelorussian and Carpathian Military Districts. In the Byelorussian MD, the battalions were deployed with tank crews in motor rifle divisions to provide long-range fire support during mechanized operations. In the Carpathian MD, they were deployed as separate corps- or army-level tank destroyer battalions with artillery crews. Neither approach was especially successful. The tankers did not

The Obiekt 757 was one of a number of experimental missile tanks developed in the late 1950s. It was armed with the 125mm D-125S gun that could fire either the Rubin guided antitank missile or the Bur unguided high-explosive projectile. The chassis was based on the T-10M heavy tank with the improved suspension of the Obiekt 770 tank. One is seen here preserved at the V. Zadorozhniy Technical Museum.

like the IT-1 as it only had 15 3M7 Drakon missiles on board, and it could only be fired from long range since it had a dead zone of about 300–500 meters before the guidance system could take over control of the missile. The artillery crews didn't like it as it was a complicated vehicle to service and operate compared to conventional guns. It had extremely good accuracy for its day, and the commander of one of the battalions later recalled that during the 1970 Dvina wargames, his unit scored a dozen hits with a dozen missiles. Nevertheless, the concept had fallen out of favor and it was retired very soon after its deployment starting in 1972–73; the chassis were converted into recovery vehicles. Development of other missile tanks was cancelled formally on February 16, 1968, when attention turned to the idea of using a new 125mm guided projectile from the forthcoming D-81T gun.

Besides the dedicated missile tank destroyers, experiments were conducted with mounting ATGMs on tanks as supplementary weapons. In January 1962, the Nizhni-Tagil plant started development of a launch system for two 9M14 Malyutka (AT-3 Sagger) missiles, located on the right rear side of the T-62 turret. About 50 tanks were converted and subjected to troop trials. In 1966–67 a further 30 tanks were converted, and at least some were deployed experimentally with Soviet units in Germany. The larger Falanga missile was experimentally mounted on some T-10M tanks. In the event, the configuration was abandoned, in part due to the explosive hazard of an externally mounted missile, as well as the problems of operating the missile from inside the tank.

As was the case with NATO, the Soviet Army came to realize that there was no particular reason to deploy ATGMs from tanks or tank surrogates. Instead, lightly armored vehicles offered a more economical choice. The ATGMs had sufficient range that lightly armored tank destroyers could sit back away from the forward-edge-of-battle (FEBA) and still engage targets. The Soviet Army first adopted ATGM tank destroyers in August 1960. The lightest of these was the 2P26 based on the GAZ69 4x4 light truck and armed with four wire-guided 3M6 Shmel missiles (AT-1 Snapper). The other two were based on the BRDM-1 armored car. The low-end was the 2P27 armed with the wire-guided 3M6 Shmel and the high end was the 2P32

The only Soviet missile tank to reach serial production was the IT-1, armed with the 2K4 Drakon missile system. The radio-command guided 3M7 missile was stowed in the hull, and elevated through a roof hatch for firing, a single missile at a time.

with the longer-ranged, radio-guided 3M11 Falanga missile (AT-2 Swatter). All three types went into mass production, and these configurations remained the preferred style for Soviet tank destroyers for the remainder of the Cold War. Soviet antitank missile production skyrocketed from 2,000 during the first year of production in 1961, to 12,600 by 1965, 25,000 in 1972, and 70,000 annually by 1983.

Soviet tank production 1960–75

	PT-76B	T-55	T-62	T-64	T-72	T-10M	Total
1960	105	2,294				198	2,597
1961	121	2,330	25			202	2,678
1962	112	2,071	275			170	2,628
1963	204	740	1,100			100	2,144
1964	191	630	1,600			90	2,511
1965	69	470	1,500			60	2,099
1966	134	720	1,420	300			2,574
1967	97	700	1,505	330			2,632
1968		750	1,957	425			3,132
1969		800	1,970	270			3,040
1970		810	2,280	490			3,580
1971		392	2,215	400			3,007
1972		470	2,209	400			3,079
1973		385	1,620	500	30		2,535
1974		535		600	220		1,355
1975		535		700	700		1,935
Total	**1,033**	**14,632**	**19,676**	**4,415**	**950**	**820**	**41,526**

The new standard tank

By the mid-1960s, many Soviet commanders recognized that a technological shift had occurred and that NATO tanks had leapt forward beyond their Soviet counterparts in combat effectiveness. This was to some extent due to the cancellation of promising heavy tank designs, and the related restrictions in weight of the new medium tanks. It was very difficult to cram a powerful gun and thick armor into a 35-tonne tank when some NATO tanks were already in the 50-tonne range. The following chart is a Soviet assessment of the tank balance in the early 1960s with the T-55 assessed at a combat effectiveness level of 1, and then the performance of the other tanks compared against it. As can be seen, the Soviet Army rated the NATO tanks as two or three times more effective than the T-55 and T-62.

Comparative military technical co-efficients

Tank	T-55	T-62	M60A1	Leopard 1A1	Chieftain Mk. 1
Country	USSR	USSR	USA	Germany	UK
Combat-technical value	1.0	1.35	2.2	2.2	3.0

The revolutionary new T-64/Obiekt 432 tank was in the works, but it would cause considerable controversy in the Soviet Army for nearly two decades. The Obiekt 430 was powered by an unconventional opposed piston diesel engine, influenced by the German Jumo 205 aircraft engine, which promised exceptional performance in a very compact size. Likewise, the

suspension system was designed for the lightest weight possible. Composite armor was considered for both the hull and glacis plate. Composite armors consist of conventional steel armor, but with cavities of other materials, usually some form of silica or aluminum. The advantage of composite armors was that they offered superior performance to homogenous steel armor against shaped charge warheads such as those used on tank HEAT (High-explosive antitank) projectiles and antitank guided missiles. This was an important consideration in the late 1950s when NATO tanks relied primarily on HEAT ammunition for tank-vs.-tank fighting.

Development of Morozov's revolutionary new tank was delayed by the technical immaturity of some of its components, as well as the turmoil in the early 1960s over future tank guns as described previously. The baseline Obiekt 430 was ready for production in the early 1960s, but production was cancelled when the Soviet Army turned from the 100mm D54-T gun to the 115mm gun. The improved Obiekt 432 used the new 115mm D68-T gun, delaying production for three or four years.

Production of the Obiekt 432 totaled 218 tanks by the end of 1964. These tanks, still considered experimental, were first deployed for troop trials with the 41st Guards Tank Division headquartered at Chugyevo near Kharkov in Ukraine. The initial trials ended in February–March 1964 with scathing complaints about the engine durability and other issues. After improvements were introduced, further trials of a new batch of tanks were conducted by the 37th Guards Tank Division of the Byelorussian Military District. The September–November tests still found lingering engine and suspension problems. Later tests of the autoloader found that it malfunctioned nearly a third of the time.

Besides the technical problems with the Obiekt 432, Kremlin officials were concerned over its high cost. A T-62 tank took 5,855 man-hours to build, but the T-64 required 22,564 man-hours, four times as much. In terms of cost, the price for a T-62 in 1973 was 62,000 rubles compared to 143,000 for the T-64A, more than double the price.

In spite of these concerns, the Obiekt 432 was belatedly accepted for Soviet Army service as the T-64 tank on December 30, 1966. In August 1967, the Kremlin ordered that all tank factories would switch to the production of the T-64 starting in 1968. The Kirov factory in Leningrad was to begin in 1968, followed by Nizhni-Tagil, Omsk and Chelyabinsk in 1970. The standardization scheme continually slipped due to the unsolved technical problems with the T-64. In May 1969, the plan to start T-64 production at Omsk was pushed back from 1972 to 1974. The Kremlin allowed two of the tank plants to begin work on alternative engines for the T-64, the Obiekt 439 with V-45 diesel engine at Nizhni-Tagil and the Obiekt 219 with the GTD-1000T gas turbine in Leningrad. These would later evolve into the T-72 and T-80 tanks.

Total production of the basic T-64 tank in 1964–68 was 1,192 tanks. Due to the lingering problems with these tanks, their use was confined to the Byelorussian Military District and the Carpathian Military District in western Ukraine. None were ever deployed with the premier tank units of the GSFG.

The T-64 had a very rocky reception when it entered army service. This was not only due to its lingering technical problems, but also the army's failure to recognize the need for more thorough training due to its greater complexity. One later study concluded that the crew workload in the T-64

The original T-64 (Obiekt 432) tank was armed with a 115mm gun. These tanks never served in the Group of Soviet Forces – Germany, and were retained in Belarus and Ukraine. This T-64 is seen on summer exercise as it disembarks from a GSP-tracked ferry.

was about 2.2 times greater than the older T-62. A senior Soviet tank engineer later remarked that "The T-64 was a lot like a soldier wearing polished boots; they were light, comfortable and pretty – but only for a parade. In combat it was better to have ordinary felt boots."

Adding to the T-64's problems was the recognition that the 115mm gun was inadequate, especially compared to NATO guns such as the 120mm gun on the Chieftain tank. Work was already underway on the Obiekt 434 with the new D81-T 125mm gun, but it took time to incorporate this into the T-64 due to its very limited internal volume. The first Obiekt 434 tanks were delivered for trials in the summer of 1966 and it was approved for army use in May 1968 as the T-64A. Production began in late 1968 and the first serial production tanks were delivered in January 1969. Initial troop testing of the T-64A in August–September 1969 appeared to be favorable.

By 1970, the T-64A finally seemed to be reaching maturity. In the autumn of 1970, the Kiev Military District conducted an exercise by the 42nd Tank Division, fully equipped with the T-64 tank. Of the 330 tanks taking part in the maneuvers, only 22 broke down. A January 1971 report noted that T-64 reliability had improved three-fold based on trial results in 1969–70. This exercise was conducted as part of an effort to start deploying the T-64 in the GSFG. The T-64A was first deployed with the GSFG in 1976, starting with the 16th Guards Tank Division at Neustrelitz and the 35th Motor Rifle Division at Doberitz.

As a consequence of the technical problems of the T-64, the Kremlin authorized Kartsev's bureau at Nizhni-Tagil to adapt the V-46 diesel engine to the T-64. This was a derivative of the V-55 engine used on the T-55 and T-62. At the same time, the bureau mounted a more durable suspension

B

THE WARSAW PACT ON MANEUVERS

The Soviet armed forces and their Warsaw Pact allies conducted large-scale exercises through most of the Cold War. A typical exercise was the 1966 Vltava exercise held in southern Bohemia in Czechoslovakia in September 1966. This took place in the vicinity of the Vltava river and was the largest joint maneuvers of the Warsaw Pact armies since their inception, involving the armies of the USSR, Czechoslovakia, the German Democratic Republic, and the Hungarian People's Republic. Subsequent large-scale maneuvers included the Visla–Elba (Vistula–Elbe) in 1971, Baltika in 1972, and Zapad (West) in 1973. The large exercises typically included multiple scenarios such as airlanding operations, tactical nuclear strikes, and elaborate engineer river-crossing operations. They were often used as a method to display important new types of equipment to the Warsaw Pact members as in this scene of a T-62 tank attack supported by Mi-24 attack helicopters.

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on the Obiekt 172. This shared the basic gun and armament system of the T-64A, but with a substantially new chassis. It was accepted for Soviet Army service in August 1973 as the T-72 and started production at Nizhni-Tagil in November 1973. The rationale for accepting the T-72 into production simultaneously with the T-64 was that it was less costly since it used less elaborate fire controls. As a result, it could serve as a wartime "mobilization tank" that could be quickly built in larger numbers. Also, it could be manufactured by the other Warsaw Pact countries. This decision would become controversial in later years.

Warsaw Pact

Both Czechoslovakia and Poland were already license-producing the T-54A tank and switched to T-55 production in 1964. This program was part of a larger Soviet effort to have the Warsaw Pact countries provide more of their own weapons.

In 1962, Poland began negotiations to switch to T-55 production at Zakłady Mechaniczne Bumar-Labędy. The first ten T-55 were turned over to the Polish Army in 1964. By the end of 1965, there were 128 Polish-manufactured T-55 in service. Production of the T-55A began in 1968, and by 1970 there were 956 T-55/T-55A tanks in Polish service. Total production of the T-55 and its variants in Poland up to 1981 was around 5,000 vehicles, the majority of which were exported.

The ZŤS-Martin plant in Czechoslovakia switched production from the T-54A tank to the T-55 in 1964 and in 1967 switched to the T-55A, producing it through 1982. As in the case of Poland, the majority of the tanks were manufactured for export, going to other Warsaw Pact armies as well as clients in the Middle East and elsewhere.

Czechoslovak T-55 tank production 1964–1982		
T-55 domestic	**T-55 export**	**Total**
687	442	1,129
T-55A domestic	**T-55A export**	**Total**
1,506	5,690	7,196
Domestic Total	**Export Total**	**Total**
2,193	6,132	8,325

The Polish and Czechoslovak T-55 production was heavily oriented towards export within the Warsaw Pact. The East German *Nationalen Volksarmee* (NVA) provides a typical example, with the Soviet Union providing the original tanks, but the bulk of the tanks coming from imports from Czechoslovakia and Poland.

East German T-54/T-55 acquisition				
	T-54	**T-54A**	**T-55**	**T-55A**
Soviet	210			
Czechoslovak			374	1,392
Polish		488	2	331

One of the minor mysteries of this era was the absence of production of the T-62 in Czechoslovakia and Poland. Soviet production of the T-62 ended in 1972, yet production of the T-55A continued in the Warsaw Pact

states for a decade afterwards. There have been some suggestions that Poland and Czechoslovakia balked at the license production fees demanded by the Soviets for T-62 production, but a definitive account of this policy is still lacking. Both countries shifted to T-72 production in the 1980s.

The baseline M60 tank, sometimes dubbed the M60A0, used a hemispherical turret similar but not identical to that of the M48 Patton. These tanks have been daubed with mud for improvised camouflage during the October 1973 Reforger V exercises near Walkmuhle, Germany.

United States

Tank development in the United States in the early 1960s followed a similar pattern to the Soviet Union, pursuing both revolutionary and evolutionary approaches. The revolutionary approach was the T95 tank, initiated in 1954. The program intended to develop a novel new tank able to fulfil the roles of both the M48 90mm gun tank and the M103 120mm gun tank. The T95 design considered several new smooth-bore tank guns, a sophisticated light-beam rangefinder and new composite armors. The first pilot tanks were ready in 1958 and put through their trials. Some of the technologies used on the T95 were not mature enough and caused endless delays, notably the optical rangefinder. The US Congress was critical of both the complexity and cost of the vehicle, and anxious over the prospect of a new battle tank likely to suffer from the same teething pains experienced in the M47/M48 Patton programs. The program was cancelled on July 7, 1960. By this time, a decision had been made to pursue a less radical and more evolutionary design, the M60 tank.

The British inspection of the armor on a Soviet T-54A tank in Budapest in 1956 led to the development of the Royal Ordnance L7 105mm gun. This gun was tested by the US Army as part of the T95 program and was found to be superior to other available and experimental tank weapons. After redesigning the breech, the United States adopted it as the M68 105mm gun. It was successfully fitted into an M48A2 turret, but the army was not satisfied with the fuel economy of existing gasoline tank engines. The new Teledyne Continental AVDS 1790-2 diesel proved to more economical solution. Along with the 105mm gun, the AVDS 1790-2 formed the basis for a deep modernization of the M48 series, redesignated as the M60 105mm gun tank.

The M60A1 underwent gradual improvements in the 1960s and 1970s. This is a M60A1(AOS) with the thickened turret cheek armor, serving with 4-69th Armor in Germany during training exercises in April 1974. It is painted in the MASSTER camouflage scheme, peculiar to Seventh Army in USAREUR.

Although similar in appearance to the M48A3, the M60 used a new rolled steel glacis plate instead of the cast front hull of the M48 series. The US Army tested several composite armor packages including aluminum and silica inserts sandwiched between steel. These armors were found to have better performance when subjected to shaped-charge warheads at oblique angles. However, the new armor packages were abandoned in favor of conventional steel armor since it was felt that the ballistic advantages were outweighed by higher costs, problems repairing damaged armor, and other factors.

The Shillelagh gun/missile system offered a powerful weapon system that could be adapted to a light vehicle such as the M551 Sheridan Armored Reconnaissance Airborne Assault Vehicle. This photo shows a 1967 test-firing of the associated MGM-51 missile.

The original M60 tank used a dome-shaped turret very similar to the M48 series except for the substitution of a larger M19 cupola for the old M1 cupola. The M60 also dispensed with a stereoscopic rangefinder, instead using a coincidence rangefinder. The M60 proved to be short-lived as the turret armor was judged to be inadequate. The turret was completely redesigned with a much larger bustle, and the improved version entered production in 1962 as the M60A1.

The missile tank debacle

As was the case in the Soviet Union, the US Army became interested in tube-fired guided missiles as an alternative to conventional tank guns. The two main attractions were long-range accuracy and superior armor penetration. The US Army's 152mm XM81 Shillelagh Combat Vehicle Weapon System (CVWS) missile/gun weapon was based around a 152mm guided missile and a gun/launcher that could also fire conventional high-explosive projectiles. On paper, the Shillelagh missile had an 80 percent probability of a hit on a target at 1,500 meters, while the 105mm gun on the M60A1 firing an APDS round had about a 75 percent hit probability. Furthermore, the accuracy of the conventional 105mm gun dropped off precipitously at ranges over 1,500 meters while the Shillelagh retained a good accuracy as far as 3,000 meters. The Shillelagh's HEAT warhead also had significantly greater armor penetration due to its large diameter.

The initial application for the Shillelagh was the US Army's new light tank program. After design studies in 1959, the program began in the summer of 1960 as the M551 Armored Reconnaissance Airborne Assault Vehicle (AR/AAV). It was intended to fulfill the dual roles of an armored cavalry light tank and an airborne tank. The Shillelagh was an extremely attractive option since it offered substantially greater firepower than the 76mm gun used in the previous M41 light tank, yet at the same time could be mounted on a light vehicle due to its low recoil. Test firings of the new MGM-51A Shillelagh missile began in 1961 and it was approved for limited production on August 12, 1964. Twelve XM551 pilot tanks were built and entered tests in June 1962. The design was extremely challenging due to the strict weight limit desired in order to make it light enough to be dropped by air-delivery, while at the same time incorporating systems to permit it to be amphibious. Substantial problems in the test program led to five major redesigns of the XM551 pilot tanks.

A patrol of the 11th Armored Cavalry along the inter-German border in May 1979 staged by an overly dramatic public affairs officer. The M551A1 Armored Reconnaissance Airborne Assault Vehicle on the right and M113A1 armored personnel carrier on the left are painted in the 7th Army camouflage scheme, commonly seen in the mid-late 1970s in Germany.

The M551 Sheridan was approved as standard in May 1966 and production funding was included in the Fiscal Year 1966 (FY66) budget. The premature standardization was approved largely due to concern that to do otherwise would lead to the loss of funding in FY67 and

the cancellation of the production contract, effectively killing the program. As late as March 1966, the army's testing command concluded that "it is not suitable for Army use because of specified safety, durability, reliability, performance, training, and maintenance limits." One of the main issues was the use of consumable propellant cases for the 152mm ammunition. These tended to rupture, spilling propellant and potentially leading to a catastrophic ammunition explosion. Tropical tests in 1967 found that the problems were so dangerous that Sheridan crews were prohibited from carrying more than a single round of ammunition in the tank at one time. This curtailed the deployment of Sheridans beyond trials and training units until early 1968 and hundreds of newly manufactured Sheridans sat idle at depots.

Improvements were gradually introduced and the Sheridan officially entered service use in June 1967 with 1/63rd Armor at Ft Riley, Kansas. Authorization for overseas deployment came in October 1968, followed by authorization for Eighth Army in Korea in November 1968 and US Army Europe (USAREUR) in January 1969. By the autumn of 1971 there were about 800 Sheridans deployed including 40 in Korea, 310 in Europe, 250 in the United States, and about 200 in Vietnam.

ABOVE LEFT
The M60A2 adapted the new Shillelagh gun/missile launcher to the M60 chassis using a new, low-profile turret. The new turret was surmounted by a massive commander's cupola, denying any height advantage from the small turret profile. This is from the initial production series that can be identified by the fume extractor on the gun barrel.

ABOVE RIGHT
Prior to the introduction of passive image-intensification sights in the late 1970s, US tanks still relied on the AN/VSS-1(V)1 Infrared Searchlight for night-fighting as seen on this late production M60A2 tank. The later production batch of M60A2 can be identified by the smooth gun barrel without the prominent fume extractor.

Radical alternatives

The US Army regarded the M60A1 as a stop-gap much as the Soviet Army regarded the T-62. In 1963, the US Army began another revolutionary tank

Many armies shifted to the use of antitank missile launchers mounted on light armored vehicles instead of gun-tube tank missiles. This is a M113A1 with the M233 TOW mounting kit and ballistic cover, serving with the 3rd Infantry Division during the Carbon Edge exercise of Reforger 77 in Germany in September 1977. Behind it is a Leopard 1A3 tank of the "Vandoos," the Canadian Royal 22nd Regiment.

The XM803 was a last-gasp effort to revive the MBT-70 program by placating Congress with a low-cost version. By this time, the US Congress was fed up with cost-overruns during the program, as well as the tank's inordinately high cost.

program as a cooperative venture with Germany called Main Battle Tank 70/Kampfpanzer 70. The MBT-70 was also based on the 152mm Shillelagh gun/missile launcher. The MBT-70 had full weapon stabilization to allow for fire-on-the-move. In order to shield the crew in a chemically or radioactively contaminated environment, the crew was located in the large turret, with the driver having a station that rotated to keep him facing forward regardless of turret orientation. The program proved to be far too ambitious and expensive. By 1969, the program costs had escalated to five times those initially agreed upon, and the Germans withdrew. The Bundeswehr was beginning to receive its new Leopard MBTs and felt no particular pressure to field another new tank. The US Congress urged the army to terminate the program in the face of the mounting costs of the Vietnam War. If production plans had proceeded, the MBT-70 would have cost more than three times as much as the M60. The army agreed to develop a more austere version, called the XM803, which dispensed with such gimmicks as its remote-control 20mm autocannon at the rear of the turret. Problems with the 152mm Shillelagh gun/missile system on the M551 and M60A2 tanks also soured Congress on the program, and it was halted in 1971.

In parallel, an effort was started to mount the Shillelagh on the M60 tank as the M60A2. Several turret configurations were studied but a low-silhouette design was selected. A premature production authorization led to 300 hulls and 243 turrets being manufactured in 1968 before the vehicle had been adequately tested. The plan was to re-equip a number of older M60s with the new turret, and transfer the M60 turrets with their 105mm gun over to some old M48s, resulting in the M48A4. A variety of fixes were adopted to solve the problems, including the addition of a scavenger system to the breech to prevent hot propellant debris from entering the turret, similar to what was done to the Sheridan. The delay in solving the Shillelagh problems led to the decision to drop the M48A4 scheme after a few prototypes had been built. A total of 526 M60A2 tanks were built in 1973–75, some using the new hulls from 1958, and some using recycled M60 hulls.

The M60A2 tanks were used primarily for six tank battalions stationed with the USAREUR in Germany. The complexity of the M60A2 led some crews in Germany to nickname the M60A2 the 'Starship.' Technical improvements in the fire controls on the M60A1 and new ammunition technology lessened the advantage the M60A2 enjoyed in long-range duels. In 1980, the US Army considered rebuilding the M60A2s with M48 turrets and 105mm guns. The M60A2 was withdrawn from service in 1981 and its hulls used for other M60 variants such as AVLB (Armored Vehicle Launched Bridge).

US tank production 1960–1975								
	M48A5	**M60**	**M60A1**	**M60A2**	**AVLB**	**M728**	**M551**	**Total**
1960		420						420
1961		910						910
1962		875	145					1,020
1963			720					720
1964			585		56			641
1965			306		113	20		439
1966			288		4	68	28	388
1967			126		31	30	471	658
1968			170	(300)**	30	28	440	668
1969			175			17	361	553
1970			252		18	12	362	644
1971			278		48	30		356
1972			346		69	38		453
1973			140	268	4			412
1974			344	277				621
1975	108		651	31				790
Total	**108***	**2,205**	**4,526**	**576***	**373**	**243**	**1,662**	**9,693**

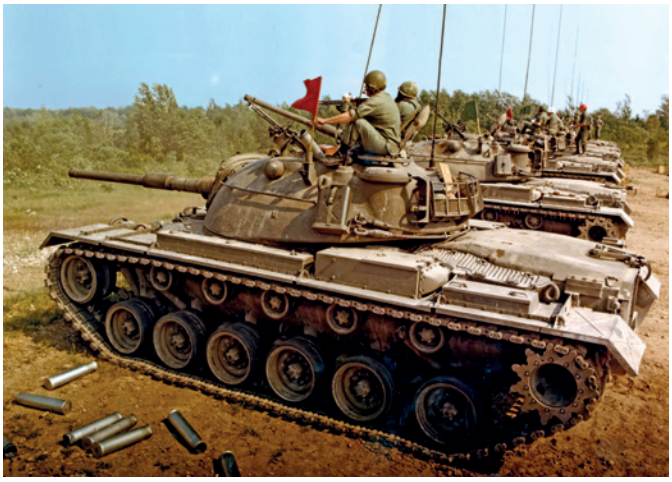
**Retrofit*
***300 M60A2 built but not accepted in 1968*

M48/M60 Improvements

The decade long technical debacle with the Shillelagh meant that the M60A1 remained the primary tank of the USAREUR. There was a continual string of improvements on the tank during the 1960s and early 1970s. The first improvement was the addition of a top-loading air filter in 1971. A more significant improvement was the Add-On Stabilization (AOS) system in 1972 resulting in the M60A1 (AOS). The AOS system allowed the tank to fire accurately while on the move. The next phase was the addition of a "reliability improvement of selected equipment" (RISE) engine, the AVDS 1790-2D with an improved electrical harness. This resulted in the M60A1 (RISE). The next configuration was the M60A1 (RISE Passive) that was equipped with AN/VVS-2 passive night sights for the driver and M35E1 gunner's sight. This version also included a deep-water fording kit. This upgrade package was introduced in 1977.

During the 1973 Middle-East War, the M60A1 was found to be well armored except in the chin area under the front of the turret and the turret ring, which suffered a disproportionate number of penetrations. An additional armor fillet was added under the chin to correct this, and the turret ring casting was thickened on new production tanks. This upgrade did not receive a specific designation change. Since 1979, the product-improved M60A1s were fitted

The final version of the M60A1 family was the M60A1 (RISE-Passive) as seen here from a tank of the 1st Cavalry Division. This introduced image-intensification night sights as well as the RISE engine upgrades. This tank also has the added turret chin armor, introduced after the 1973 Middle-East War.



ABOVE LEFT
The US Army upgraded its M48 Patton tanks starting in 1975 into the M48A5 configuration with the 105mm gun. This particular tank was upgraded from a M48A1 and is fitted with the new low-profile commander's hatch. These tanks served in the Army National Guard, in this case with 1-110th Armor.

ABOVE RIGHT
The British Army paid close attention to the rise of antitank missiles in the 1960s. This is a training exercise using a Vickers Vigilant antitank missile in 1961, with a pair of Centurion tanks in the background.

with M239 smoke launchers, which are an American derivative of the type used on the British Chieftain tank.

A modernization effort was started in the early 1970s to bring older M48A1 and M48A3 tanks closer to the M60A1 in capabilities. The basic upgrade for the M48A5 was the addition of the M68 105mm gun. The upgrade program started in 1975. A portion of the conversions based on the M48A3 retained the M1 commander's cupola and the G350 turret riser with the AVDS-1790-2A engine. Another series called M48A5 (Low Profile), was remanufactured primarily on old M48A1 tanks and fitted with a low-profile tank commander's cupola with two M60D pintle-mounted machine guns on the turret roof; this version used the AVDS-1790-2D engine. A total of 1,573 M48A5s were re-manufactured in 1975–79 for the US Army National Guard, as well as several hundred others for international clients.

United Kingdom

During the Hungarian Revolt of 1956, insurgents in Budapest drove a captured Soviet T-54A tank to the British embassy where it was inspected by the military attaché's office. The thickness of the frontal armor proved very worrying and led to the development of the Royal Ordnance L7 105mm gun. During the 1960s, this would become the standard gun on most front-line NATO main battle tanks. In the case of the British Army, some of the more recent Centurion production types including the Mks 5, 7, and 8 were retrofitted with the new gun, being re-designated as Mks 5/2, 7/2, and 8/2.

C

CHIEFTAIN MK. 6, 4 RTR, BRITISH ARMY OF THE RHINE, GERMANY

The archetypical British Army temperate scheme in the BAOR in Germany was a base color of Deep Bronze Green overpainted with a camouflage pattern of black. These schemes were not standardized although certain styles prevailed. The green paint was originally in a gloss finish, but the BAOR complained that this made the vehicles too obvious to the enemy due to its reflectivity. In the late 1960s, there was a shift to matt finishes, as well as initial steps to field paints that were less visible under infrared light. Standard markings included the vehicle registration number, carried on both front and rear, and a black/white convoy safety marking, carried centrally on the rear. A Union Jack decal was often applied on one of the front mud-guards. The reduced-visibility NATO bridging circle was painted on the front in gray and black. The 4 RTR painted the "Chinese Eye" on either front side of the turret, a tradition dating back to World War I tanks. Vehicle names were standard, in this case honoring Lt. Col. H.W. Dakeyne, commander of the 4 Bn. RTC at Catterick in the mid-1930s.

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DAKEYNE

DAKEYNE

The Royal Ordnance L7 105mm gun was developed to deal with the armor of the T-54 tank of the mid-1950s. It began to be adopted by many NATO armies in 1959–60. This is a Centurion Mk. 12 named "Ostridge" that served as a forward observation post (OP) with the 35 Field Battery Royal Artillery before its retirement.

The final production series in 1959–62, the Centurion Mk. 10, had the 105mm gun fitted from the outset. This armament upgrade was undertaken by other NATO armies equipped with the Centurion including Denmark and the Netherlands.

In 1958, the British General Staff released a requirement for a new "Main Battle Tank" with the firepower of the Conqueror, the mobility of the Centurion, and the maximum armor package possible within a 45-ton tank. Trials of the new tank, eventually named the Chieftain, began in 1960. The Chieftain was armed with the new rifled L11 120mm gun. Propulsion was provided by the Leyland L60 opposed-piston engine. Some of the novel features of the new design such as electric loading assist, were eventually discarded, while other desired features, such as a laser-rangefinder, were not yet ready. Weight steadily escalated to over 50 tons by the time the Chieftain was accepted for service in May 1963. The 40 Chieftain Mk. 1 tanks were used for troop trials and training. The first service variant, the Mk. 2, was produced in 1966 and entered service with the 11th Hussars in November 1966. The Chieftain underwent continual upgrade, with the Mk. 5 introduced in 1972.

This Chieftain was originally built as a Mk. 2, but was later upgraded to Mk. 6/4 standards. It served with the 4 RTR.

The Leyland L60 engine proved to be the Achilles heel of the design with prolonged reliability problems, an echo of similar problems with the Soviet engine in the T-64. In contrast, the 120mm gun and associated fire controls were highly rated, and it was the most powerful tank weapon in NATO until the arrival of the Rheinmetall 120mm smooth-bore more than a decade later.

Britain faced a difficult economic dilemma when attempting to remain competitive in main battle tank design. Considerable emphasis was

The Netherlands examined the Leopard 1, Chieftain, and AMX30 for its future tank. This is an interesting comparison: the Leopard 1 on the left and Chieftain on the right during Dutch trials at Leusderheide in February 1968. (Nationaal Archief)

placed on tank exports, since by spreading the cost of research and production facilities across a larger production run, individual tank costs could be driven down. As a result, more Chieftains and its derivates were sold overseas than to the British Army. In total, the British Army ordered about 810 Chieftains of the various marks, not counting the Armoured Recovery Vehicle. Total production through 1985 was 2,265 tanks and over 300 ARV and AVLB variants, with most of the export going to the Middle East.

Britain took a different approach to a new light tank than the US Army's M551 Sheridan. Instead of opting for a powerful main gun, the new design relied on light guns on the presumption that reconnaissance would be accomplished by stealth rather than firepower. Rather than a single type of weapon, the Combat Vehicle Reconnaissance (Tracked) involved a family of vehicles with numerous armament options. The CVR(T) variants included the baseline FV 101 Scorpion with 76mm gun, the FV 107 Scimitar with a 30mm autocannon, and the FV 102 Striker with Swingfire antitank missiles. There were unarmed alternatives as well such as the FV 103 Spartan armored personnel carrier. The CVR(T) family was accepted for service in 1970 with about 1,500 vehicles built for the British Army and RAF. Besides their use by the British Army, they were also adopted in NATO by Belgium. The CVR(T) family proved very successful in the export market with total production of over 3,000 vehicles for more than 20 armies.

The Scorpion Combat Vehicle Reconnaissance (Tracked) was part of a family of light armored vehicles. Behind this Scorpion of the 14th/20th King's Hussars is a Striker, the antitank version of the family, armed with Swingfire antitank missiles.

West Germany

In 1956, the German government decided to pursue the local production of a Standard-Panzer to eventually replace the M48 Patton

The Bundeswehr continued to use the M48 well into the 1980s, but with upgrades. This is a M48A2CG of Panzer-Regiment.200 during the *Reforger IV* exercise in January 1973. It has been retrofitted with a German infrared searchlight, stowage bin, and smoke grenade launchers.

obtained from the United States. Since both France and Italy had similar goals, in 1957–58, negotiations led to a trilateral program called the Europa Tank. The design placed emphasis on firepower and mobility rather than armored protection in order to keep the weight down to 30 tonnes. Different designs were offered by three German firms, and a fourth by the French Atelier de Construction Moulineaux (AMX). Initial trials of the German Leopard prototypes began in 1962 and the French AMX 30 prototypes in 1963. Germany eventually decided to use the British L7 105mm gun as the basis for its designs while France opted for a new 105mm smooth-bore gun.

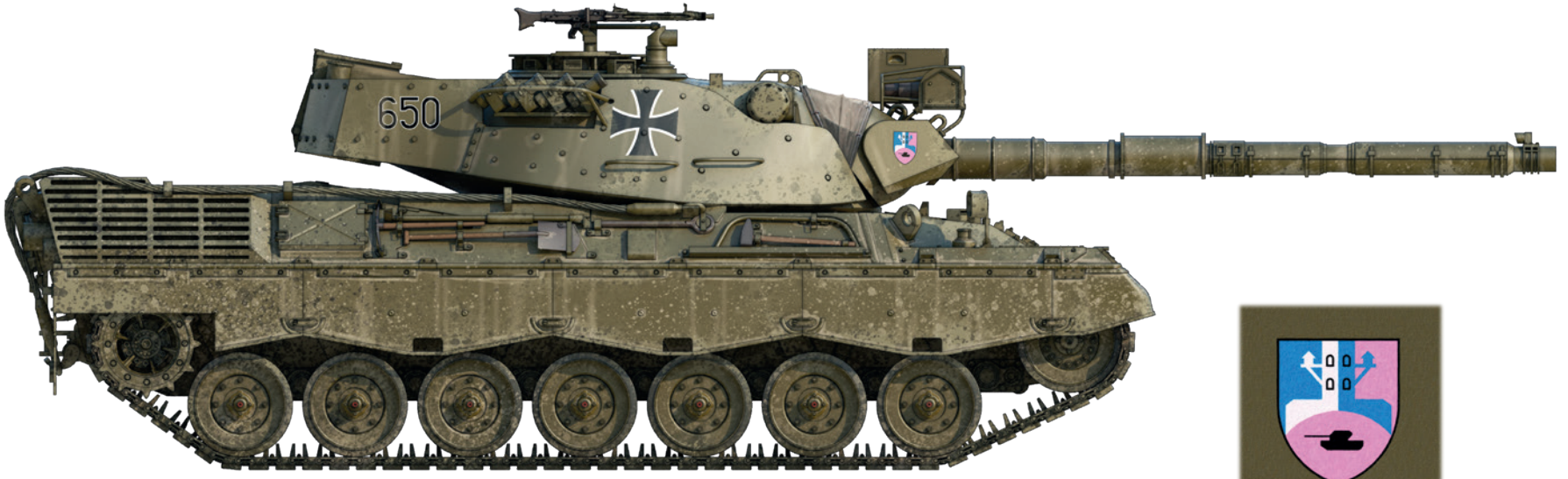
Joint trials convinced the Bundeswehr that their Leopard design offered better mobility and that the L7 gun was more versatile due to a wider range of ammunition types. As a result, Germany proceeded with production of Leopard Standard-Panzer, with Krauss-Maffei delivering the first serial production tank in September 1965. OTO-Melara in Italy was awarded license production rights with 200 tanks for the Italian Army obtained directly from Germany, and 720 built in Italy. Belgium and the Netherlands had participated in the Europa Tank program as observers, and decided to follow the German lead and acquire the Leopard tank.

The Leopard 1 underwent continual upgrades from the outset. The first major variant was the Leopard 1A1 which included gun stabilization, a thermal jacket for the gun, new tracks and side skirts, deep-fording equipment, and a new air filter. The original German Leopard 1 tanks manufactured in 1965–70 were upgraded to Leopard 1A1 standards starting in 1972. The next production batch of German tanks, the Leopard 1A2, had a reinforced cast turret and passive night vision sights for the driver and commander. The next

D

LEOPARD 1A1A2, 4./PANZERBATAILLON.114, GERMANY

In 1956, the Bundeswehr adopted its own olive drab paint, RAL 6014 ALT Gelboliv. This was very similar to the US olive drab of the same period. The Bundeswehr gradually adopted standard tactical markings by the 1970s and this is a typical example of the common style. The markings on the turret include the national insignia, a Maltese cross, a three-digit tactical number, and the battalion crest on the side of the mantlet. The battalion crest was usually carried only on the right side as seen here. The markings on the front include a standard NATO yellow/black bridging circle on the right, a Bundeswehr license plate in the lower center, and the white tactical unit marking, based on standard NATO map symbols. The markings on the rear are similar to those on the front except for the presence of the white convoy warning cross on a plaque in the center.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The Bundeswehr continued to upgrade its older M48 tanks into the late 1970s. Wegmann converted 650 tanks into the M48A2GA2 standards with a 105mm gun in a new mantlet, a new commander's cupola, image intensification sights, and other upgrades. These were deployed with territorial units since the regular army was receiving the new Leopard 1 at the time.

production series was the Leopard 1A3 which introduced a welded turret instead of the previous cast turret. The final regular production series, the Leopard 1A4 in 1974–76, introduced an integrated fire control system and other improvements. Some Leopard 1A1 tanks were retrofitted with reinforced turret armor, being designated as Leopard 1A1A1. In the 1980s, the Leopard 1A5 configuration was developed which was used to retrofit older tanks.

The Leopard 1 became the standard NATO tank of its generation with about half of total production going to eight other NATO armies. In many cases, the export versions of the Leopard 1 tank incorporated some detail differences from the original German types.

Norway ordered 78 of the Leopard 1A1 Standard-Panzer in 1968, receiving them in 1970–71. In contrast to the baseline version, this variant had gun stabilization and a thermal sleeve on the 105mm gun barrel. Two are seen here in winter camouflage during the joint NATO Exercise *Alloy Express* in March 1982.

A Leopard 1A1A1 of the 1.Zug, 4.Kompanie, Pz.Btl.153, Pz.Bde.15 of the 5.Panzer Division near Ehfolderbach in Hesse in September 1983 during the NATO *Reforger-83* autumn wargames. These tanks were built in the baseline Leopard 1 configuration, upgraded to 1A1 standards with gun stabilization, and then to the Leopard 1A1A1 standards in 1975–78 with Blohm+Voss appliqué turret armor.

Leopard standard-Panzer in NATO*

	Leopard 1	1A2	1A3	1A4
Belgium	334			
Canada			114	
Denmark			120	
Germany	1,845	232	110	250
Greece*			181	
Italy	200	720		
Netherlands	468			
Norway	78			
Turkey	227			

**Leopards ordered from Germany; some NATO countries received additional tanks in later years as transfers from other NATO armies*

The Bundeswehr showed little interest in tube-fired antitank missiles but was an early customer for the French Nord Aviation SS11. A dedicated missile tank destroyer vehicle was introduced as the Raketenjagdpanzer 1 in 1961

The Leopard 1A3 introduced a new welded turret in place of the previous cast turret. In 1976–77, Denmark acquired 120 of these in the Leopard 1A3DK variant which had many small changes including a cleaning system for the periscopes, attachments for a dozer blade, and US radios. This example is seen in a wooded ambush position during NATO exercises in 1984.

Germany participated with the US Army in developing the Kampfpanzer 70 for its future requirements. This example is preserved at the Deutsches Panzermuseum in Munster. (US Army Acquisition Support Center)

on the HS.30 armored personnel carrier. It was supplanted by the Raketenjagdpanzer 2 in 1967 that was based on the same chassis as the Kanonenjagdpanzer 90, armed with a 90mm gun. Each Panzergrenadier brigade had two tank destroyer companies each equipped with eight of these vehicles while the tank destroyer companies of the Panzer brigades had 13 each.

Although Germany had obtained a small number of M41 light tanks from the United States, the preference for a future reconnaissance vehicle focused on wheeled vehicles, with the Spähpanzer Luchs entering development in 1968 and entering production in 1975.

France

Although France nominally remained in NATO, in 1966, all French troops were removed from NATO's integrated military command, and all non-French NATO units were asked to leave France. The French government had already decided to proceed with the AMX30 tank even before the final joint trials with the German Leopard were completed in 1963. The prototype versions of the AMX30 were subsequently designated as AMX30A and the production version as AMX30B. Production started in 1966 for 1,173 of the baseline AMX30B. A second tranche of 62 of the improved AMX30B2 were completed in 1981–82 when production for the French Army ended. There were numerous changes made during AMX30B production, and a portion of the AMX30B tanks were later upgraded to AMX30B2 standards. France's withdrawal from NATO, its use of a local gun/ammunition system, and the delayed start of serial production discouraged export of the AMX30B within NATO. In the event, 190 were purchased by Greece, and Spain obtained 45 of which 26 were locally assembled based on French-supplied kits.

The French Army upgraded a portion of its AMX 13 fleet with the new Nord Aviation SS11 guided antitank missile with four missiles mounted on each tank.

The AMX30B became the standard tank of the French Army in the mid-1960s, serving into the 1980s until the advent of the new Leclerc tank. Unlike most other NATO tanks of the era, it used a smooth-bore 105mm gun of French design instead of the ubiquitous British L7 105mm rifled gun.

Besides the baseline tank, the French Army also caught missile fever and developed the gun-fired ACRA (*Anti-Char Rapide Autopropulsé*) 142mm missile. This effort started in 1961 and was strongly influenced by the US Army Shillelagh. Development was quite protracted and flight tests began in 1971. In the event, the high costs of the missiles soured the French Army and the program petered out in 1974.

Since the early 1950s, the French Army acquired 1,735 AMX13 light tanks and so had little need for a new type. The main focus was increasing its firepower. This was done in two ways. The French Army had already begun to adopt the Nord Aviation SS11 wire-guided antitank missile. There were various schemes to deploy vehicle-mounted missiles including the conversion of older M24 light tanks. In 1960, the AMX13 was selected with a special system that allowed four missiles to be mounted on launchers on the turret front on either side of the main gun. These conversions began to be deployed in 1963 and at least 200 conversions were made. Each light tank regiment received a squadron of 12 missile tanks. Likewise, tank regiments with the older M47 tanks received a squadron, but not the regiments with the new AMX30B since it had adequate antitank firepower. After the 1967 army reorganization, the mechanized infantry regiments received a platoon of four AMX13 SS11 missile tanks.

In the late 1950s, the Atelier de Bourges developed a re-bored 90mm version of the CN-75-50 gun that armed the existing AMX13 but permitted the use of the 90mm HEAT projectile. Starting in 1966, all 875 AMX13 Mle 51s underwent a "Revalorisation" program to the AMX13 C90 configuration with the program completed in the early 1970s. There were other upgrades developed for the AMX13 including a 105mm gun, but these were aimed at the export market more than the French Army.

A camouflaged Norwegian Leopard 1A1 in an ambush position along Highway E-6 during Exercise *Teamwork-88* in September 1988. These tanks underwent the 1A1 upgrade program in the 1970s, and were substantially upgraded in the 1990s into the Leopard 1A5NO configuration.

The Soviet Army staged Operation *Dunai* in August 1968 to crush the "Prague Spring" liberalization effort. This is a T-10M, painted with the white invasion cross used during the operation. The 9th and 13th Guards Heavy Tank Divisions took part in the operation.

TANKS IN BATTLE

There were never any tank clashes between NATO and the Warsaw Pact, so "lessons-learned" were confined to combat outside of Europe.

The Soviet Army saw very little tank combat in this period. The largest military action of the era was Operation *Dunai*, the 1968 invasion of Czechoslovakia. The Soviet Army deployed 18 tank, motor rifle, and airborne divisions into Czechoslovakia, including more than 5,000 tanks and other armored vehicles. The operation also involved contingents from other Warsaw Pact states including Poland, East Germany, Hungary, and Bulgaria. Unlike Hungary in 1956, there was no significant fighting in 1968.

There were some small but violent clashes along the Ussuri river with the Chinese Army in 1969. This led to the loss of one T-62 tank to the Chinese, an event far more consequential to Chinese tank development than to the Soviets.

US forces saw a number of overseas deployments during this period including the April 1965 intervention in the Dominican Civil War. The US Marines BLT 3/6 (Battalion Landing Team) deployed a reinforced tank platoon of seven M48A3 tanks and some M50 Ontos tank-destroyers. They saw a few one-sided engagements against the insurgents' old Landsverk

E

T-10M, 9TH HEAVY TANK DIVISION, 1ST GUARDS TANK ARMY, CENTRAL FRONT, OPERATION DUNAI, PLZEŇ, CZECHOSLOVAKIA, OCTOBER 1968

Prior to the invasion of Czechoslovakia in August 1968, Warsaw Pact tank units received instructions to paint a 25–30cm wide white cross over the roofs of their vehicles as an air identification marking to avoid confusion with Czechoslovak tanks. This was a standard Soviet air identification marking widely used since the 1930s, and indeed the same one adopted for the assault on Berlin in April 1945. Temporary movement markings were assigned to all units, mainly to facilitate traffic control by military police units. The shape of the outer symbol appears to identify the higher formation (army, division, etc.) within the geometric symbol, the upper number identified the vehicle, the lower numbers were an arbitrarily assigned unit identification number followed by the convoy serial number. Some units maintained their usual three-digit tactical side numbers. This tank is typical of Cold War patterns in overall camouflage green (*zashchitniiy zeleno*) an extremely dark green when new; a US match is FS 34098.

10
3-4

ABOVE LEFT
The US Army and Marine Corps relied on the older M48A3 in Vietnam since there was no significant enemy tank threat. This is a tank of the 2-34th Armor, supporting the 25th Infantry Division near Cu Chi on January 23, 1969.

ABOVE RIGHT
A M551 Sheridan of the 3-4th Cavalry in Vietnam during its initial combat deployment in December 1969. One of the first field modifications by the unit was to place an anti-RPG screen on the bow of the vehicle using chain link fence. The Vietnam Sheridans had their missile guidance system removed, dubbed the "Two Box" configuration.

L-60 light tanks and AMX13 tanks, a rare example of tank fighting in the Americas.

The largest combat commitment of US tanks during this period was the Vietnam War. US Army and US Marine Corps M48A3 were widely used in the infantry support role. There was only one tank-vs.-tank engagement between the US Army 1-69th Armor and PT-76 light amphibious tanks of the NVA 202nd Armored Regiment at Ben Het Camp in March 1969. There was no need for more powerful tanks, and so the M60A1 was never deployed to Vietnam except for a small number of the M728 Combat Engineer Vehicle. The M551 Sheridan was deployed in significant numbers to Vietnam, hoping that it would win its combat spurs after a messy period of development. It was not well regarded due to its technical flaws and its greater vulnerability to rocket-propelled grenades and mines due to its light armor. There were extensive tank-vs.-tank battles between the ARVN (Army of the Republic of Vietnam) and the North Vietnamese Army in 1972–75 after the US had withdrawn from the conflict, but few tank lessons were drawn from these encounters.

One of the more obscure but significant lessons during the later stages of the Vietnam War was the relative effectiveness of the first two generations of

The only armed version of the M60 to serve in Vietnam was the M728 Combat Engineer Vehicle, armed with a 165mm demolition gun. This M728 served with the 1st Brigade, 5th Mechanized Infantry Division near Quang Tri in August 1968.

antitank missiles. The US Army was still using old SS11 antitank missiles fired from helicopters at the start of the 1972 Quang Tri offensive. The SS11 used first-generation MCLOS (manual command line-of-sight) guidance, that was steered by the gunner using a joystick. Subsequently, the newer BGM-71 TOW arrived that used the second-generation SACLOS (semi-automatic command line-of-sight) guidance. The newer guidance method provided markedly higher hit rates with only about 1 hit per 70 launches for the SS11, while for the TOW it was about 1 for every 2, about 35 times better. This difference is worth bearing in mind in the discussion below about the use of the Soviet Malyutka missile in the 1973 Middle-East War.

The extensive use of the Malyutka ("Baby": NATO designation AT-3 Sagger) antitank guided missile during the 1973 war revolutionized ground warfare. This shows the components of the 9K11M Malyutka system.

The Indo-Pakistan wars of 1965 and 1971 involved large numbers of modern tanks on both sides. Some attention was paid to the clashes between Pakistani M47 and Indian Centurion tanks in the 1965 war, but by this time, neither type was the latest in the NATO inventory. A more relevant conflict was the 1967 "Six Day War" in the Middle East, which pitted Israel against Egypt, Syria, and Jordan. Both Egypt and Syria had a significant number of modern Soviet tank types including the T-54A, while Israel had Centurion and M48A2 tanks. The tank fighting contained no technical surprises for foreign observers, as the outcome of the battles was determined by the superior training and tactics of the Israel Defense Forces (IDF) rather than technological issues.

In contrast, the 1973 Middle-East War was intensely studied by both the Warsaw Pact and NATO. By this time, the Arab armies had received more modern Soviet equipment including the T-62 tank and 9M14 Malyutka (AT-3 Sagger) antitank missiles. Tanks played a central role in the original Egyptian and Syrian offensives. NATO studied these battles since they provided an example of an outnumbered force battling off a numerically superior force. Observers viewed this as a surrogate for a NATO/Warsaw Pact confrontation since the Arab armies had been trained in Soviet tactics and used contemporary Soviet equipment.

The 1973 Middle-East War saw the combat debut of the T-62. This is a T-62 from the original production series belonging to the Egyptian 25th Armored Brigade as it crosses to the west bank of the Suez on February 14, 1974, following a UN brokered disengagement agreement. This is one of a handful of tanks of the brigade to have survived a violent ambush by the Israeli 217th Armored Brigade on October 17, 1973, during the fighting around the Deversoir Suez crossing point.

There were numerous technical lessons drawn as well. For the first time, guided antitank tank missiles had a major impact on the battlefield, especially the Egyptian use of the Malyutka missile in the Sinai fighting. At the outset of the war, the Egyptian army had 721 ATGM launchers and the Syrians had 212. At first, the heavy Israeli tank losses in the Sinai were attributed primarily to the Malyutka. US Army tank expert Gen. Donn Starry later recalled that "all of Washington was agog with the notion that the tank was dead; the guided antitank missile had made the tank obsolete." The Israelis

The Israeli army provided the US Army with a number of captured Syrian tanks, especially the new T-62 for test and evaluation. This is a T-62 Model 1972 which was characterized by the added 12.7mm DShK antiaircraft machine-gun mounting over the commander's station on the right side of the turret.

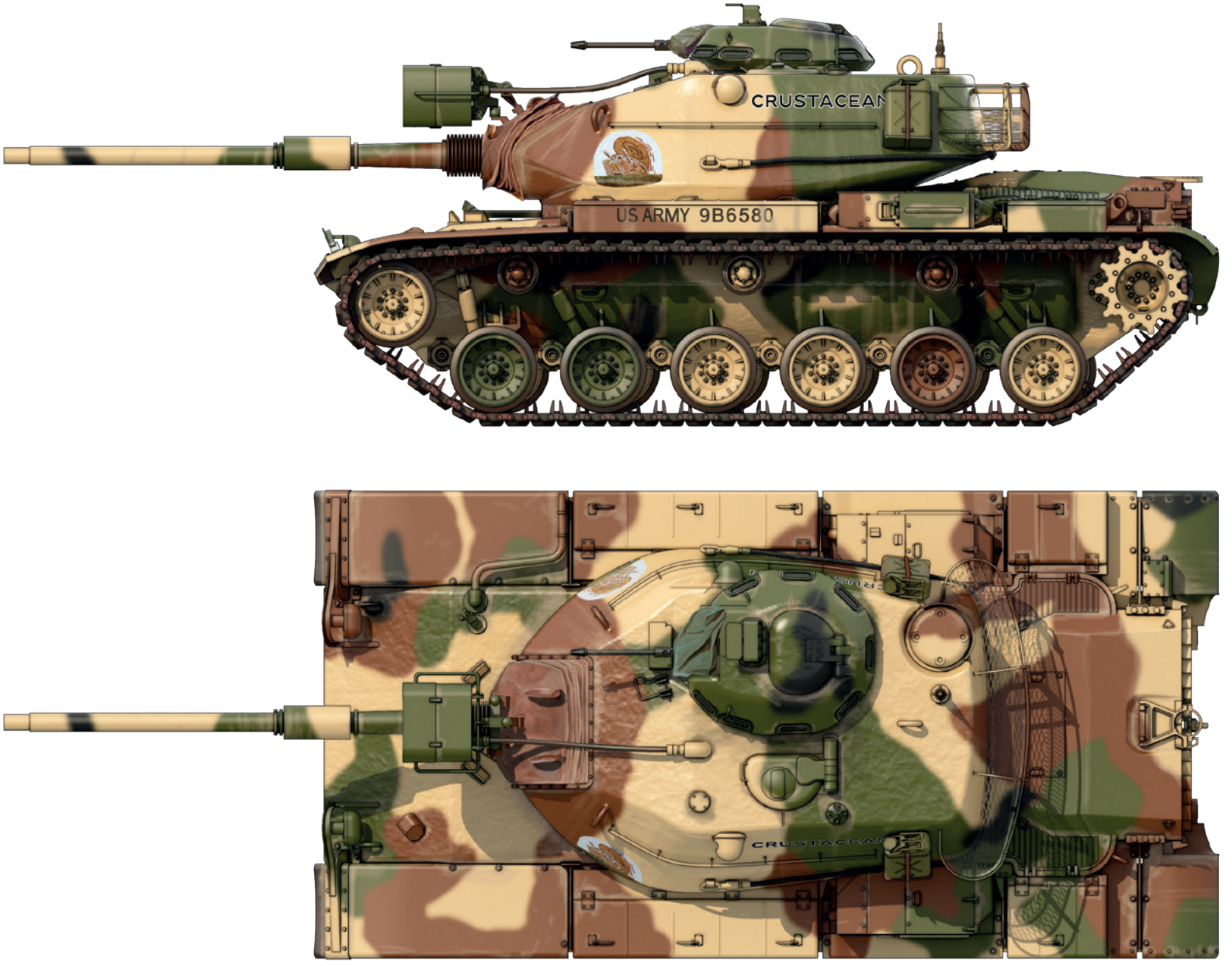
estimated that the Arab armies had launched 6,000 to 8,000 ATGMs during the fighting, and the Arab armies claimed they had knocked out 800 Israeli tanks. The US Department of Defense dispatched several teams to examine the lessons of the conflict. These studies provided a more sober assessment of the missile threat. One US team examined 119 Israeli tank wrecks in the Sinai and found that eight definitely were knocked out by Malyutkas, three by Malyutka in combination with other weapons and 18 from unidentified shaped-charge warheads. Therefore, 7–24 percent of the tank casualties were due to Malyutkas. A later Israeli study found that of 214 tanks recovered from the Sinai, 26 percent were victims of the Malyutka. As mentioned above, these early MCLOS-guided missiles had a very low probability of kill. Assuming that 7,000 missiles were fired and about 250 tanks damaged or destroyed, this suggested a success ratio of 1:28 or a 3.5 percent probability of hit.

Regardless of the precise numbers, the lethality of these weapons would be a major incentive in the development of composite armor during the 1970s and 1980s. The US studies also concluded that the high Israeli tank casualties were in part due to Israeli over-emphasis on tank-focused tactics and a corresponding disregard for combined-arms tactics with accompanying infantry. It was also evident that the early missile successes were due to their surprise. Within a few days of fighting, the Israeli army adapted their tactics to the new threat with a corresponding drop in missile casualties.

F

M60A1, "CRUSTACEAN", COMPANY C, 4-73RD ARMOR, GERMANY

In the early 1970s, the US Army Modern Army Selected Systems Tests, Evaluation and Review (MASSTER) at Ft Hood, Texas, began experimenting with possible camouflage schemes as a replacement to the previous olive drab. As part of this effort, the VII Corps of USAREUR began their own experiments that were codified under USAREUR Regulations. This scheme consisted of two primary colors, FS 30117 Rust Brown and FS 30372 Sand, each covering 40 percent of the surface with smaller patches of FS 34079 Forest Green and FS 37038 Black. Insignia and markings were to be applied in black. It quickly became evident that the black markings were hard to see, so units used contrasting colors such as sand or white over dark areas. The VII Corps scheme began to appear on USAREUR tanks in 1973, and became widespread by the middle of the decade. This particular tank had the bumper codes painted in white (C-4-73, C-24) and the registration number on the side in black (US ARMY 9B6580). The author would like to thank the driver of this tank, Brian Gibbs, for his help in detailing the markings of this tank.


CRUSTACEAN
US ARMY 9B6580

The 1973 war also saw the first widespread combat use of APFSDS (armor-piercing, fin-stabilized, discarding-sabot) projectiles by Syrian T-62 tanks. This marked a technological turning point away from HEAT to APFSDS as the principal type of ammunition in tank-vs.-tank fighting. This led to the introduction of the US Army's M735 105mm APFSDS in 1978 and the Israeli M111 105mm APFSDS prior to the 1982 conflict. Both of these rounds were widely adopted within NATO in the late 1970s and early 1980s.

TECHNICAL ANALYSIS

Firepower

The new generation of tanks appearing in 1965–70 introduced several new tank guns, notably the British L7 105mm gun, Soviet 115mm gun, British 120mm gun, and Soviet 125mm gun. It is impossible to provide a detailed performance comparison of all these guns for two reasons. To begin with, the ammunition of these guns evolved from 1960 to 1975, with multiple ammunition types for each gun. Secondly, unclassified performance data for these guns is often lacking. In many cases, the testing standards for the various armies varied, so performance data in many cases is not comparable. The chart below provides a very rough comparison of the guns based on the common ammunition type for tank fighting available in 1970.

Comparative technical data of NATO and Warsaw Pact Tank Guns 1970

Caliber	105mm	105mm	105mm	105mm	115mm	120mm	125mm	152mm
Country	UK	USA	USA	France	USSR	UK	USSR	USA
Designation	L7	M68	M68	CN105F1	U5-T	L11	D81-T	M81
Length	L/54	L/54	L/54	L/56	L/53	L/55	L/51	L/16
Type	rifled	rifled	rifled	smooth	smooth	rifled	smooth	smooth
Ammunition	APDS	APFSDS	HEAT	HEAT	APFSDS	APDS	APFSDS	ATGM
Designation	L28	M735	M456	OCC-105-Mle 62	BM4	L15	BM9	MGM-51
Muzzle velocity (m/s)	1,475	1,500	1,170	800	1,615	1,350	1,800	320
Projectile weight (kg)	5.8	4.65	10.2	10.9	5.34	10.0	6.5	26.8
Penetration in mm at 30° @2,000m	102	120	220	170	110	130	150	200

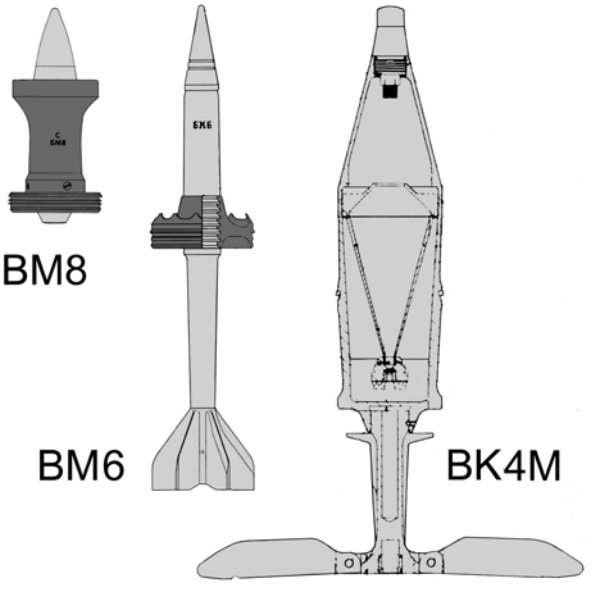
During the 1960s, most NATO armies depended on HEAT (high-explosive antitank) projectiles for tank fighting since these offered better armor penetration than contemporary APDS (armor-piercing, discarding-sabot). HEAT projectiles used a shaped-charge warhead that compressed the metal liner of the warhead into a hypersonic stream of metal particles that penetrated the enemy tank armor. The British Army had a traditional preference for HESH (high-explosive, squash-head) over HEAT. This worked on a different principle than HEAT. The high-explosive warhead deformed on contact with the enemy tank armor, and the resulting explosion caused the interior of the armor plate to spall, throwing off chunks of steel scab into the tank interior.

The advent of smooth-bore guns was in part due to the widespread use of HEAT ammunition. The performance of shaped-charge warheads is degraded by spin, and smooth-bore guns made it somewhat simpler to use projectiles that minimized spin.

APDS was the most common form of kinetic energy penetrators in use by NATO in the early 1960s. These contained a sub-caliber penetrator, often

of a heavy and dense alloy such as tungsten carbide. This offered much higher speed than the types of armor-piercing ammunition used in World War II. APDS was preferred for some engagements since the projectiles had a flatter trajectory than HEAT rounds, requiring less elaborate corrections for range. The HEAT rounds usually were slower than APDS, and often fitted with pop-out fins to stabilize them for better shaped-charge performance. This made them more vulnerable to cross-wind drift.

The next generation of kinetic energy penetrators was APFSDS (armor-piercing, fin-stabilized discarding-sabot). These were similar in concept to APDS but used a finned, long-rod penetrator that offered superior accuracy at longer ranges. Development of this type started in 1951, but proved difficult since its length meant that the fins were located within the propellant casing. When fired, the fins were subject to deformation by the propellent detonation. As a result, this type of kinetic energy penetrator did not emerge as a mature projectile until the early 1960s. As mentioned earlier, the T-62 was the first tank to regularly use this type of ammunition.



This illustration shows the typical projectile types used for tank-vs.-tank fighting in the 1960s and early 1970s, in this case for the Soviet U5-TS 115mm gun. They include the BM8 armor-piercing, discarding-sabot (APDS), the BM3 armor-piercing, fin-stabilized, discarding-sabot (APFSDS) and the BK4M high-explosive, antitank (HEAT).

The Soviet Army preferred to use APFSDS for tank-vs.-tank fighting in the newer tanks with smooth-bore guns such as the T-62 and T-64. Two different types of projectiles were originally available, a less-expensive type such as the 3BM6 that used a monobloc hard-steel penetrator, and a more expensive type using a tungsten-carbide core such as the 3BM3. The tungsten-carbide type was reserved for war use, and was generally not exported during this period. So the Egyptian and Syrian armies were supplied with the monobloc steel penetrators. Soviet tanks were also issued HEAT ammunition. This could be used in tank fighting, but it was more versatile than APFSDS since it was also effective against non-armored targets such as vehicles and fortifications.

The effectiveness of these various types of weapons were heavily dependent on their interaction with the many different types of opposing tanks and their differing armor arrays. The Soviet Army calculated the effective engagement ranges at which different NATO tanks could be defeated by specific Soviet tank types. Two of these charts are reproduced here, one comparing the ranges at which the T-62 could defeat common NATO tanks, and the other comparing the ranges at which NATO tanks could defeat the T-62.

T-62 vs. NATO tanks

Range (m) at which penetration is possible

	Leopard 1		**M60**		**Chieftain**	
Projectile*	3BM3	3BM6	3BM3	3BM6	3BM3	3BM6
Glacis	>3,000	>3,000	800	900	500	900
Lower hull	>3,000	>3,000	2,700	2,800	>3,000	>3,000
Turret front	>3,000	>3,000	2,800	2,000	2,800	2,000

**3BM3 = APFSDS with tungsten-carbide core; 3BM6 = APFSDS with monobloc steel penetrator.*

NATO tanks vs. T-62			
Range (m) at which penetration is possible			
	105mm APDS	105mm APFSDS	120mm APDS
Glacis	1,400	>3,000	3,000
Lower hull	2,500	>3,000	>3,000
Turret front	1,000	>3,000	2,500

Fire control

The effectiveness of tank guns was dependent not only on their ammunition, but on their fire control systems. One of the major changes in tank design in the 1960s and 1970s was the advent of advanced fire controls that included gun-stabilization, ballistic computers, and advanced range-finders. Single-axis stabilization had been in use since the M4 Sherman tank of World War II, and became more common on tanks in the 1950s. During the 1960s and 1970s, stabilization systems were introduced that provided all-axis stabilization, giving tanks true fire-on-the-move capability. A good example of this was the M60A1 (AOS) upgrade in 1972.

Optical rangefinders became common in the 1960s such as on the M60, Leopard 1, AMX-30, and others. However, the Soviet Army was unwilling to accept the cost of such systems, as well as the large internal turret volume required. This was one of the incentives for the development of APFSDS since these high-velocity rounds did not require the amount of ballistic correction needed in other forms of ammunition such as HEAT. Britain preferred to use ranging guns, which were essentially a co-axial machine gun that had ballistic performance similar to the main gun. Tracer rounds could be fired from the ranging gun, and once the target was hit, the main gun could be fired with a high probability of a hit.

Mechanical ballistic computers began to appear in tank fire control systems in the 1950s in order to improve long-range accuracy. These computers were used to quickly calculate ballistic corrections based on range, ammunition type, and wind drift. They did not become widespread until the late 1970s when they could be incorporated into an integrated fire control system including laser range finders, and wind sensors.

BELOW LEFT
Typical fire controls of Soviet tanks of the 1960s and 1970s can be seen in this view of the gunner's station of Czechoslovak-manufactured T-55. In the upper left is the gunner's TPN-1-22-11 infrared night sight while below it on the left side is the turret traverse motors. On the right side is the TSh2B-32P telescopic sight, while below it are the gunner's hand controls.

BELOW RIGHT
The growing complexity of tank fire controls in the 1960s is clearly evident in this interior view of a M60A1 tank looking towards the commander's station on the right and the gunner's station in the center behind the 105mm gun.

Night vision systems still relied on active infrared searchlights until the mid-1970s. Image intensification sights for infantry weapons appeared in the late 1960s. These devices amplified ambient light to permit night engagements. The amplification and durability were not sufficient for tank gunnery until the advent of the M35E1 gunner's sight and AN/VVS-2 driver's sight on the M60A1 RISE-Passive in 1978. They became increasingly common in the 1980s.

The 1960s saw the first widespread research on tank autoloading systems. This was necessary in part due to the growing weight of large-caliber tank gun ammunition that made manual loading increasingly difficult. An intermediate step was loading-assist systems as tried on the Chieftain. The Soviet Union was the first country to make widespread use of auto-loaders, in no small measure due to the limited internal volume of the turret of tanks such as the T-64.

Protection

Rolled homogenous steel armor (RHA) and cast steel armor remained the predominant form of tank protection through this era. The main debate was how much armor was needed. Both Germany and France wanted to keep their tanks in the 30–35 tonne range, and, as a result, their armor was significantly thinner than tanks of Britain and the United States. The USSR also aimed to keep weight down to the 35 tonne range, but accomplished this by keeping their tanks considerably smaller in internal volume. As a result, Soviet tanks were more heavily armored than NATO tanks. At the same time, small internal volume led to a small ammunition load, only 40 on the T-62 and 37 rounds on the T-64A. In contrast, the M60A1 and Chieftain carried 63–64 rounds. The Israeli army after the 1973 conflict judged the small ammunition load on Soviet tanks to be a significant drawback in their combat effectiveness.

The accompanying chart shows the armor thickness of some of the major tanks of this era. It should be kept in mind that the figures for cast armor are very approximate since the thickness varied. The slope of the armor plate dramatically affected its protective value. Although the glacis armor of most of these tanks may seem thin, the extreme slope meant that the effective thickness made them nearly impervious to penetration by kinetic energy penetrator. For example, the M60A1 had a 93mm glacis plate sloped at 65 degrees from the vertical, and so had an effective thickness of 220mm against horizontal attack.

Tank armor of the 1960s

	Leopard 1	AMX30B	M60A1	Chieftain	T-62	T-64A
Gun Mantlet	100	150	114	140	230	240
Turret front	60	80	178	125–140	188	388*
Turret side	60	40	76	120–196	120	130
Glacis	70	80	93	85	100	205*
Hull upper side	45	40	74	50	80	55

**Composite armor*

Several countries began to experiment with composite armors, though only the Soviet Union adopted this technology in this period. The main incentive for developing composite armor was the realization that the effectiveness of shaped-charge warheads from tank guns or antitank missiles could be significantly impeded by layered armor instead of conventional

homogenous steel armor. As the shaped-charge particle stream penetrated through the layers of steel and composite material, the stream could be deflected or eroded. Composite armor of this period usually involved a material such as aluminum or ceramic between layers of steel.

The Soviet Union first adopted composite armor on the T-64. The glacis plate consisted of a front layer of 80mm of medium-hardness steel armor, a center layer of 105mm of Steklopastik (fiberglass), and a backing layer of 20mm of steel at an angle of 68 degrees. This provided the equivalent of 305mm of steel armor against APDS, and 450 mm against HEAT – an impressive 45 percent improvement. The turret had a 112mm outer shell of cast, medium-hardness armor, a 138mm inner cavity filled with ceramic balls suspended in an aluminum matrix, and a final 138mm layer of cast steel at 30 degrees. This offered the equivalent of 400mm of steel armor against APDS and 450mm against HEAT, a 12.5 percent increase. The glacis armor proved very durable without posing exceptional manufacture problems. The turret composite armor proved to be very troublesome due to manufacturing difficulties, and various alternative configurations were used during the manufacture of the T-64A.

The Bundeswehr took a somewhat different approach in the 1970s, adding Blohm+Voss appliqué armor to the Leopard A1. This was 127mm thick and consisted of layers of steel armor and rubber. Its main role was to degrade the performance of the shaped-charge warheads of infantry antitank rockets rather than larger tank projectiles.

Mobility

Diesel engines were the predominant type of tank propulsion in the 1960s, largely due to better fuel economy over previous gas/petrol engines. The outliers were Britain and the Soviet Union, which both adopted opposed-piston on the Chieftain and T-64 tanks. The opposed-piston engines were inspired by the Fairbanks-Morse locomotive engines of the late 1930s and the German Jumo 003 aircraft engine. In comparison to conventional two-stroke engines with one piston per cylinder, an opposed-piston engine has a piston at the end of each cylinder, and so has no cylinder head. Opposed-piston engines were expected to be more compact than conventional tank engines since they eliminated the cylinder head and valve-train. Their flat

G

M60A2, 33RD ARMOR, 3RD ARMORED DIVISION, GERMANY

In 1972, the US Army Mobility Equipment Research and Development Command (MERDC) at Ft Belvoir, Virginia, developed a universal camouflage system that could be adapted for different climactic and terrain conditions. The camouflage scheme used four colors, two base colors that covered 45 percent each of the surface and two contrast colors covering the remaining area. The idea was that the scheme could be rapidly adapted from one season to the next by changing only one color. The most used patterns were "Winter US-Europe-Verdant" as seen here, and "Summer US-Europe-Verdant". The difference in the two schemes was that the winter scheme used Field Drab FS 30118 as one of its base colors, while the summer scheme used Light Green FS34151 instead. The other three colors were the same and consisted of the base color of Forest Green FS34079 and the two contrast colors of Sand FS30277 and Black FS37038. The contrast colors were usually applied in what was nicknamed a "crow's feet" design.

This scheme was first widely applied to the 2nd Armored Division at Ft Hood, Texas, and it eventually spread to USAREUR, eventually supplanting the local VII Corps scheme displayed in the previous plate. The adoption of the MERDC camouflage also incorporated a shift in the base color of US military vehicles from the previous olive drab to the new forest green color. This was most evident on newly manufactured vehicles.

configuration reduced the height of the engine. In practice, both engines had prolonged teething problems and poor reliability during their initial service life. In the Soviet case, the development of the diesel-powered T-72 and gas-turbine powered T-80 were largely due to the problems with the opposed-piston engine of the T-64.

Tank comparisons

How did the various NATO and Warsaw Pact tanks compare overall in this period? It is difficult to make an overall assessment in such a short book due to the sheer number of different tank types involved. Fortunately, there is at least one broad assessment that offers a tantalizing hint of the way that the Warsaw Pact viewed the technological balance.

This comparison was made by the Center for Operational and Strategic Research of the Soviet General Staff (TsOSI-GSVS-SSSR). These computer-based assessments were based on firepower, mobility, survivability, command and control, and other technical factors. The US Central Intelligence Agency obtained a copy of the secret August 1977 summary, which was subsequently declassified under the Freedom of Information Act. It forms the basis for the chart here. A second version, released in 1991, was mainly used to fill in additional older types of tanks not included in the 1977 edition.

Combat effectiveness of NATO/Warsaw Pact tanks:	
The Soviet Assessment *	
PT-76	0.48
T-34-85	0.49
AMX13 (90mm gun)	0.54
Centurion 3 (20 pdr)	0.7
IS-2M	0.7
T-44	0.75
AMX-13 (75mm w. SS-11)	0.8
IT-1	0.8
IS-3	0.83
M551	0.83
Centurion (105mm)	0.85
T-54	0.87
T-54A	0.9
T-54B	0.9
M48/M48A1	1.0
T-55	1.0
T-62	1.0
AMX30	1.1
Leopard 1	1.1
M47	1.1
M60A1	1.1
Chieftain Mk. 5	1.5
Leopard 1A4	1.5
T-64A	1.5
T-10M	1.51
M60A2	2.2

** Tsentr operativno-strategicheskikh issledovanniy Generalnogo shtaba VS-SSSR, "Resultati rascheta koeffitsientov soizmerimosti obraztsov vooruzheniya I voennoy tekhniki I voyskovikh formirovaniy SSSR i NATO", 1991.*

The Soviet assessment usually begins by choosing a particular tank as the baseline, and it is given the value of "1." Then, the other weapons are given values relative to the baseline tank. In this chart, the baseline is the T-55 tank. Tanks with a score lower than "1" are regarded as inferior to the T-55; tanks with a value higher than "1" are regarded as superior.

The Soviet assessment has several oddities. The M47 is rated higher than either the T-55 or M48, and equivalent to the M60A1. Such an assessment is bizarre. The value for the T-10M is remarkably high, narrowly edging out even the T-64A. Poor data or a poor algorithm? It's hard to tell from the available information. Furthermore, these assessments do not tally very well with another Soviet assessment cited here on p. 13. Even if imperfect, it provides a starting point for a comparison.

FURTHER READING

There are numerous monographs dealing with specific tank types of this era. This reading list avoids these due to their sheer number and instead highlights broader national surveys.

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GLOSSARY

APDS	armor-piercing, discarding-sabot
APFSDS	armor-piercing, fin-stabilized, discarding-sabot
ATGM	Antitank Guided Missile
AVLB	Armored vehicle launched bridge
GSFG	Group of Soviet Forces – Germany (*Gruppa sovetskikh voysk v Germanii*)
GSVG	(*see* GSFG)
HEAT	High-explosive antitank
MBT	Main Battle Tank
NATO	North Atlantic Treaty Organization
Ton	short ton (2,000lb)
Tonne	metric ton (1,000kg; 2,200lb)
USAREUR	US Army – Europe